How to Improve China's Electricity Pricing System Through the Experience of Alberta Canada

Grace Li Tian

Canada Climate Change Law and Policy Research Center, Canada
John F. Kennedy School of Government, Harvard University, MA 02138, USA
Email: grace@ccclp.ca & gracetian@hks.harvard.edu

Abstract: This paper examines China's electricity pricing system through a comparative analysis with Alberta's experience in electricity market reform. As the world's largest electricity supplier, China's pricing mechanism remains heavily administrative and monopolistic, leading to inefficient resource allocation and financial losses for power generators. Through analyzing the legal framework and implementation challenges in China's electricity pricing system, this study identifies three major issues: the disconnect between government-set prices and market costs, monopolistic control by state-owned transmission companies, and insufficient public participation in price-setting processes. Drawing from Alberta's successful market-oriented reforms since 1995, particularly its Power Purchase Arrangements (PPAs), independent system operator model, and transparent public hearing mechanisms, this paper proposes targeted solutions for China's electricity pricing reform. The recommendations include establishing an independent electricity trading platform, implementing asset divestiture to break vertical monopolies, and enhancing pricing transparency through regulatory reform. This research contributes to the ongoing discourse on electricity market reform in developing economies and provides practical insights for policymakers seeking to balance market efficiency with public interest in the power sector.

Keywords: Electricity Law; Electricity Law; Power Market Reform; Electricity Pricing; Regulatory Framework; Public Participation; Market Competition; Energy Policy; Power Purchase Arrangements; Transmission Rights; State-owned Enterprise Reform

1 Introduction

As the world's largest electricity supply country (Qiu, 2017), China's electricity tariff reform has received extensive attention. However, in the past two decades, China's electricity price reform has not been genuinely market oriented. On the whole, China's policies and legislation that regulate the electricity industry rank at a relatively low level compared to other countries. Two state-owned enterprises monopolize electricity transmission and distribution in China. A critical department of the State Council, the Provincial Development and Reform Commission (PDRC), determines the prices in the electricity industry(Daniel, 2020). The high degree of administrative monopoly results in low efficiency in resource allocation and hinders the formation of effective competition, and a large number of state-owned power generation companies have suffered losses for decades because the electricity wholesale price cannot cover their costs(Han & Qin, 2019).

Alberta is an energy-rich province in Canada; its power generation resources are similar to that of China(Hu, 2018). The difference is that Alberta's electricity system has been marketed to a very high degree, it has been unbundled to encourage competition, only the generation and retail sectors are actually competitive. Since the 1990s, Alberta has established the province's power industry structure's market-oriented foundation through the Electricity Utility Act (1995)(Brennan, 2008). Under the framework of the EUA, there are more than twenty regulations that provide guidelines for all aspects of the electricity industry and the power market in Alberta(Brennan, 2008). Alberta's electricity market is a real-time energy-only market with a system-wide uniform price(Wang, 2019).

There is a lot of research and legislation on the electricity pricing system in China, but most of them are not implemented yet(Wang, 2019). The process of unbundling is prolonged and ongoing in China. The public and most electricity enterprises' concerns could not be heard under these circumstances. This paper intends to analyze the causes of China's electric power pricing and explore the problems of China's electricity pricing mechanism. Through learning from the electricity tariff experience of Alberta, a pioneer in the electricity market reforms, this paper puts forward suggestions on power generation pricing and transmission pricing applicable to the Chinese market to promote market-oriented reform in China's electricity industry and ease the current energy shortage.

2 The legal basis and status quo of electricity pricing in China

The Chinese government introduced the Electric Power Law of the People's Republic of China to manage electric power system operation and regulate electricity pricing(Wang, 2019). The wholesale electricity, transmission, contribution and retail pricing are adopted to the "principle of unified policy and unified pricing", as Article 1 of the Chinese Electricity Law stipulated. In addition to the mandatory government pricing, there is also government guidance pricing and competitive market pricing in China's electricity industry.

The electricity generation pricing methods in China are one-part tariff and two-part tariff. The one-part pricing is the dominant one, and the two-part tariff has only been adopted in a few provinces(Lu, 2017). The on-grid tariff is determined by each PDRC and notified to each power generation company through an administrative document. The Procedure of Determining an On-grid Tariff is not open to the public(Lu, 2017). It mainly considers the combined costs of fuel costs and labor for power generation; it does not consider the depreciation costs. As Article 5 of the Chinese Electricity Law, thermal power plants and wind power plants are priced uniformly; hydropower plants still adopt a "one unit of machine one price" policy.

The price of electricity transmission and distribution is monopolized in China. There are only two power grid companies in China (China Southern Power Grid Co Ltd and China Power Grid Co Ltd), both of which are state-owned enterprises. The two companies monopolized the electricity market in different provinces(Zhao, 2018). As Article 7 of The Electric Power Law stipulated, the National DRC is responsible for the grid operation of power transmission and distribution, implements unified dispatch and hierarchical management. The Provincial DRC and the Provincial Energy Bureaus determine the transmission and distribution prices as Article 124 of Rules for the Operation of China's Power Grid stipulated. The generators have no right to negotiate prices with grid companies.

3 Leading factors affecting China's generation electricity pricing and Solutions based on the experience of Alberta.

Current situation:

The China Power Industry 2020 Annual Development Report claims that there is a gap between the Chinese government's

electricity price laws and regulations and the implementation of electricity prices. The current generation wholesale price cannot cover some plants' power generation costs; nearly half of state-owned generators have been losing money year after year, undermining investors' confidence in power investment.

To solve the power shortage and encourage private capital to access the electricity generation industry, the Chinese government formulated laws and policies to govern the standards of the marketization of power sales: loans can repay the electricity price of any of the stages from generation to retail in China as Article 5 of The Interim Measures for the Administration of Sales Tariffs stipulated, which consists of principal and interest, operating costs, profits, and taxes. This electricity price regulation makes investors reluctant to bear investment risks, and enterprises can inevitably get profits from electricity price income. Simultaneously, a considerable part of the tax revenue of local governments in China comes from power plants(Lin, 2012). Therefore, local governments often provide policy and tax incentives to the potential power plants. A large number of companies entering the electricity market in a short period of time regardless of cost, which led to a sharp increase in the cost of power stations. The average cost of power plants in 2015 was 4.2 times that of 2000(Lin, 2012).

However, when the enterprises entered the generation market, their experiences were not as beneficial as the policy guaranteed. The electricity generation price of each province is uniformly priced and allocated by the PDRC. The PDRC considers fuel costs, recovery of construction investment, reasonable profitability of power plants, and stability of electricity prices in each province to formulate a comprehensive price. Provincial general prices are announced at the beginning of each fiscal year. The generators must sell a certain amount of electricity to designated grid companies in accordance with the time instructions given by PDRC.

For the renewable plants, the actual production costs of them include loan repayment, operating costs, profits, taxes, etc.,as Article 5 of The Interim Measures for the Administration of Sales Tariffs stipulated, which are often higher than the unified pricing of the PDRC. To encourage the renewable energy production, Chinese State Council ordered local governments to grant large subsidies to renewable plants huge subsidies to those generators. In one region in 2013 the on-grid electricity price for the heat-energy plant was 0.2 CNY/kWh; the price for wind power (including subsidy) was 1.2 CNY/kWh; the residential electricity price was 0.83 CNY/kWh. This unsustainable subsidy method has brought an excessive financial burden to the local governments, so it has not been implemented for a long time, and many wind plants have suffered losses(Zhao, 2018).

For the thermal power plants who requires a large amount of coal to be purchased face significant losses because of coal price fluctuation(Lin, 2012). The price of electricity is determined by PDRC, but the operating cost of thermal power plants is directly related to the competitive coal market. When the coal market price is too high to afford, thermal power plants do not have the right to shut down their generators because the generation quota is fixed by PDRC each day. In China, most thermal generators are state-owned enterprises or state-owned capital holding companies, they regard this loss as a social balance(Chen, 2008).

Alberta's Experience and solutions:

To solve China's electricity generation pricing dilemma, Alberta's experience is worthy of reference. Unlike the Chinese NDRC 's administrative pricing, the Alberta Electric System Operator (AESO) took the form of a uniform-priced procurement auction and organized a single real-time wholesale electricity market Suppliers are required to offer (bid) in their total available generation capacity for each hour of the day(Alberta Electric System Operator (AESO), n.d.). The offer

prices should between $0 and $999.99 per megawatt-hour (MWh). Generation units are called upon to supply the power to offer prices until adequate generation is called upon to satisfy the power need. The real-time system marginal price (SMP) effectively determines every minute and equals the highest offer price accepted to supply electricity(Alberta Electric System Operator (AESO), n.d.) .The pool price is calculated as the time-weighted average SMP for each hour. The pool price is paid to all generation units that supply electricity within that hour. In 2011, the Offer Behaviour Enforcement Guidelines were released by Market Surveillance Administrator, which stated that unilateral market conduct that does not create or enhance market power is permitted(Martin, Jessica & Justin,2017). Although power plants are not restricted in their offers, explicit rules prohibit a generation company from withholding available physical generation capacity from the market(Martin, Jessica & Justin,2017). In this way, AESO requires power production companies to maximize their effectiveness without over-profitable burdens on consumers(Koplow, 2009).

Establishing an independent electricity wholesale trading platform is the best solution for China to solve the generation of electricity pricing. This wholesale electricity market platform would connect a reliable grid operation and a well-functioning spot market, making them interdependent. Electricity transactions need to consider the characteristics of electric energy and grid constraints. China can consider setting up an electricity transaction dispatch centre (ISO or RTO) that combines transaction and dispatch. Then through the centralized energy market provides a balanced and standby auxiliary service market. This wholesale market sale platform should include some mechanisms such as attracting new power generation investment by ensuring market capacity(Zhang, 2012). To avoid monopoly price manipulation, it's crucial to have a neutral third party running a wholesale power market. The NDRC and other regulators can rely on these fair and market-oriented approaches to enhance the confidence of private and foreign capital to invest in the power generations.

4 Leading factors affecting China's transmission and distribution electricity pricing and Solutions based on the experience of Alberta

4.1 China's power transmission and distribution companies monopolize the whole electricity.

The transmission companies in China manipulate the transmission, generation and retail price through their huge business volume, which has greatly hindered the marketization of the power industry.

1 In China, power transmission and distribution companies have a huge impact on the NDRC establishment of transmission tariffs. Power transmission and distribution are completely monopolized by two large state-owned enterprises : China Southern Power Grid is responsible for the investment, construction and operation of power grid businesses in five provinces(Yunnan, Guizhou, Guangxi, Guangdong and Hainan), including power transmission, transformation and power distribution. While China Power Grid Co Ltd take the remaining twenty-nine provinces' power grid businesses.

The PDRC set the rates of transmission and distribution in different provinces. The NDRC, which is the sole shareholder and investor of the two power grid companies, supervises the PDRC. The PDRC have to submit all electricity pricing to the NDRC. So, in other words, the impact of power transmission and distribution companies on transmission and distribution prices is decisive; they can require their shareholder NDRC directly, who is also the supervisor of PDRC.

The two Chinese transmission companies didn't give up their ambitions for monopoly after the unbundling. Instead, they invest in upstream (generation) and downstream (retail) companies. On August 27, 2019, China Southern Power Grid Co (Guangxi) and Guangxi Rural Investment Group jointly established Guangxi New Power Investment Group Co., Ltd. The

slogan of this company is to speed up the construction of the Guangxi "Sole Network" of electricity(China Southern Power Grid, 2019). In other words, China Southern Power Grid Co not only monopolizes power transmission and distribution in Guangxi Province but also controls nearly 30% of the province's power generation capacity. Their intention of manipulating the market and taking administrative advantage to influence power generation pricing is beyond doubt.

2 In many cases, the transmission companies in China can control the actual price of transmission. Because the generation price in each province is different, every plant wants to sell their electricity to the higher tariff province if there are inter-provincial transmission line. For example, in 2005, the wholesale price of power generation in Hunan Province was 0.23 CNY/kWh, Hunan Development and Reform Commission(2015), while the price in neighbouring Guangdong Province was 0.60CNY/kWh, Guangdong Development and Reform Commission(2015). Hunan generators must go through the China Southern Power Grid Corporation if they want to sell the electricity to Guangdong Province, because they have the transmission lines interconnected. The transmission price had been fixed by PDRC, but the China Southern Power Grid Corporation won't sign the transmission contract with any generators if they could not impose additional hidden prices on it. The power transmission company normally require the generators to invest in an unreasonable project with high costs and low benefits at this situation . In the Shaanxi Baohua electricity investment case (2002), the Baohua Power Plant and China Power Grid Co Ltd. jointly invested in a project; the power plant contributed 65% of the capital but this only accounted for 20% of the shares and earnings)(Yan, 2019). Therefore, in some situations, the transmission price actually paid by the power plants is much higher than the PDRC's fixed prices, and this invisible part of the price goes into the pocket of the transmission companies.

3 At the same time, the transmission companies have controlled the settlement rights of the entire electricity industry, affecting the pricing of power generation and retail stage(Zhao, 2009). In 2016, two supporting explanation regulations (Implementation Opinions on Promoting the Reform of the Electricity retail market and Implementation Opinions on the Establishment and Standardized Operation of Electric Power Trading Institutions) of the "Circular 9" of the Electricity Reform Act clarified that “the transmission and distribution enterprise undertake the electricity bill settlement responsibility of market entities and guarantees the safety of transaction funds." Through these two regulations, the transmission and distribution enterprises can adjust the retail price through the settlement cycle.

So far, most provinces in China have announced that they have practised the power retail market model. Electricity retail companies directly sign retail power contracts with users; at the same time, retail companies sign power purchase contracts with transmission companies. Instead of retailers, the customs pay power transmission and distribution companies directly, and the transmission company settles the retail balance to the power retail company during the settlement cycle. In China, as Article of Administrative Measures for Electricity Sale Companies stipulated, if a power retail company wants to sign a contract with a power transmission and distribution company, generally, it will have to agree with three clauses: first, The power retail company must submit to it all contracts with different types of users and all related financial statements to the transmission company, so that the transmission company can grasp the price difference in the sales process. Second, retailers must not use company funds to pay the purchase of electricity in advance but authorize the transmission and distribution company to charge the customers. Third, the retailors have to accept the longer cycle of settlement(Energy Bureau of the National Development and Reform Commission, 2022). Due to the long-unsettled period, these capital costs will all be passed on to consumers, thus driving up retail electricity prices.

4.2 Experience of Alberta and suggestion for China

Regarding regulating the transmission and distribution companies and breaking the vertical pricing monopoly of the electricity market of China, the electricity market-oriented reform practices carried out by Alberta since 1995 are very worthy of China's reference: divestiture of assets and setting up a neutral third party running a wholesale power market.

1 Divestiture of assets to break the vertical monopoly in the industry.

By 1995, Alberta was serviced mainly by three large vertically integrated utilities, namely TransAlta, ATCO (then Alberta Power), and Edmonton Power (now EPCOR, the "Big 3"). Alberta mandated that the existing generation facilities owned by the Big 3 be deregulated(Kent & Ross, 2016). To do this, Alberta removed the financial mechanisms or hedges that it had put in place when it passed the EUA. They were replaced with a forced auction, whereby the rights to the power from the output from the generation facilities of the Big 3 were sold to qualified bidders. The auction was completed using "Power Purchase Arrangements" (PPA) (Kent & Ross, 2016).

The PPA left the ownership and operation of the plants with the owners but gave the buyers of the PPAs the right to offer the electricity into the power pool at prices determined by each of the buyers. The PPAs were a virtual divestiture of the power generated by the existing facilities of the Big 3 to some extent. The owners of the generation facilities could recover their fixed and variable costs through PPAs, in the meantime it transferred the right to offer the output of those generating facilities into the power pool to the buyers who were successful in the auction(Kent & Ross, 2016).

In other words, Alberta successfully separated the actual operators of power plants and power transmission companies through PPAs. This also successfully broke the vertical monopoly of the Alberta power market. The electricity transmission would have to keep a monopoly because its nature, but it had to be separate from generation. With this essential step, the transmission enterprises cannot manipulate the price for the whole electricity industry.

The two state-owned transmission and distribution companies in China monopolize the transmission and distribution of electricity and invest in a large number of power plants(National Development and Reform Commission (NDRC), 2020). Both power plants and transmission enterprises are state-owned assets. In China, the acquisition and disposal of state-owned assets requires the approval of the State-owned Assets Supervision and Administration Commission (SASAC). The Chinese government could issue effective regulations through the SASAC to set up a system similar to PPAs, which allows state-owned enterprises and private enterprises to auction the operating rights of power plants controlled by transmission companies. This move can separate transmission and distribution companies from generation plants and prevent transmission and distribution enterprises from negatively influencing the tariff of the entire power industry. Furthermore, it can also encourage private companies to enter the power generation field, which achieves the original intention of electricity reform.

2 Setting up a neutral third party running a wholesale power market --prevents transmission and distribution companies from obtaining market settlement rights.

With the coming into force of the EUA in 1996, the cost-of-service regulation on the generation side was removed in Alberta(Banks, Giorilyn & Carnis, 2015). Alberta created its own Power Pool where all electricity, regardless of where it is generated, in their Interconnected Electrical System is traded. This is done in a transparent and open way that does not hinder fair competition. The Power Pool itself does not buy or sell electric energy but acts only as a trading platform with financial settlement(Banks, Giorilyn & Carnis, 2015).

The transmission system, where facility owners provide transmission services exclusively within a designated service

area, is defined as a natural monopoly(International Energy Agency (IEA), 1999). The transmission facility owners are regulated, due to their non-competitive nature, to ensure just and reasonable rates and safe and reliable service. Once the AUC approves a transmission facility owner's tariff, the AESO will pay the full amount of the tariff in equal monthly instalments to the transmission facility owner(Alberta Utilities Commission (AUC), n.d). The AESO recovers the costs it incurs to plan, maintain and operate Alberta's electricity transmission system through the independent system operator (ISO) tariff. The ISO tariff covers the AESO's payments to transmission facility owners, costs associated with transmission losses, system support services and administrative costs. The ISO tariff is also reviewed and approved by the AUC in a public proceeding. With such a setting, the transmission and distribution companies are unlikely to have a huge impact on transmission pricing through their natural monopoly position. The independent operation of AESO has a decisive effect on the formation of the Alberta's electricity wholesale competition market.

Therefore, setting up a neutral third party running a wholesale power market is China's top priority. The PDRCs, which is the sole shareholder of transmission companies should not play the role of tariff regulator, the Chinese government should set up a separate agency to run the electricity transmission, generation and retail market.

5 Public Participation in China's electricity pricing system and Solutions based on the experience of Alberta

5.1 Current public participation situation in China

China's process and formula for setting electricity prices are not sufficiently open and transparent(Wu, 2018). Simultaneously, it lacks public participation and remedies to balance the reasonable income of power companies and users' interests, which hinders the marketization of electricity and social fairness and justice(Lin, 2016).

Although China has been committed to market-oriented reforms in the power industry, public participation is not a high priority. China's power generation, transmission and distribution tariffs are set by the energy regulatory offices and PDRCs; retail electricity prices are set by the PDRC and the Provincial Governments. The public cannot access the power price formula and procedures(Yaojia, 2014). As Article 1 of Administrative Procedure Law of China stipulate, if customers feel their right are impaired due to power pricing, they are two remedies: one is to appeal to the office of the regulatory agency. The second is to conduct administrative litigation, which means that the companies or individuals have to sue a ministry. The litigation costs are great; the possibility of acceptance and hearing is slight. Therefore, these two remedies are useless. No company or individual has ever sued the NDRC.

To balance this situation and let power companies speak out, China has established twenty provincial power trading centers (or they should be called pricing consulting centers, because they don't handle many market trading functions(Huang, 2019). These trading centers are limited liability companies established by the transmission companies. Simply saying, the transmission companies separated their original transaction pricing department and funded it to set up the "centers" and only welcomes power companies to invest in. According to China's Corporation Law, shareholders can appoint directors and supervisors to the company according to their shareholding ratios; they can also express opinions on the company's decision-making. Electric power companies want to be heard in power trading and dispatch; the only option is to invest in these trading centers and buy themselves a seat on the board, but the board of directors does not make its major decisions, such as setting electricity rates.

5.2 The advanced experiences from Alberta

Overall, China's electricity tariff's determination provides a very limited opportunity for the public to participate, and the remedy plan is also useless. In contrast, Alberta's electricity pricing transparency and public participation is much higher, which is worthy of China's reference and emulation.

As public regulator, the Alberta Utilities Commission is responsible for making decisions about utility development in Alberta.To ensuring that Albertans, whose rights may be directly and adversely affected by utility development, have an opportunity to express their concerns and that these concerns are heard, the EUA requires regulated utilities must apply to the AUC to approve their future operating, capital costs, and utilities' terms and conditions of service(Alberta Utilities Commission (AUC), n.d.).During this regulatory process the AUC and any other involved parties can assess the applying utility’s application. They can ask clarifying questions either in writing or at an oral hearing. Any party that opposes the application also has the right to present evidence and file final submissions via argument and reply argument. All those who want to participate and express their opinions on the utility rate can submit a declaration of intent through the AUC and they can reasonably participate in the relevant sections of electricity tariff formulation. The Office of the Utilities Consumer Advocate was established by the Alberta Government to represent Albertan residential, farm, and small commercial utility consumers in regulatory rate proceedings in an effort to reduce duplication of intervener efforts and regulatory costs.

5.2 Solutions for China:

1 disclosure of costs, cross-subsidies, strengthen the transparency of electricity pricing

The Chinese government should strengthen electricity pricing transparency, support disclosure of true costs, cross-subsidies, coverage, and basic electricity consumption. To accomplish this, the Chinese government's primary task is to take the settlement rights of power transactions from the power transmission companies and legislate to establish an independent regulator to manage the power pool and other operations.

The power pricing formula should make it compulsory to disclose information and clarify the responsibilities of each pricing agency. The main responsibilities of the pricing authority should include proposing price hearing plans; pricing cost supervision and review reports; presenting the pricing hearing plan at the hearing; handling the hearing opinions by the law; public hearing opinions, etc.

The power operation agency implements and supervises the electricity price into every electricity price transaction through corresponding administrative and financial means. The different regulatory agencies perform their duties and watch each other to increase the electricity pricing transparency.

5.4 Establishing a regulator independent to the administrative system

The Chinese government should improve relevant laws for power pricing hearings, such as the "Government Price Hearing Law" and the "Government Price Decision Hearing Act”, setting up special procedures for power hearings, and introducing experts, other institutions and personnel with interests related to the hearing project(Komives, Foster, Halpern & Wodon, 2005). The Chinese public tends to avoid or remain silent at the hearings, and the expressions of stakeholders are also relatively moderate in the hearings. Because they do not want to stand on the opposite side of the administrative organizations, they fear the effect of administrative power(Enserink & Koppenjan, 2007). Therefore, separating the power pricing from administrative organizations is the most critical step for the public to participate in power pricing in China

(Duren, 2005).

6 Conclusion

Alberta's advanced experience of electricity pricing marketization, such as using PPAs to break the monopoly, setting up independent power system operators, establishing real-time wholesale power markets, discoursing of costs, cross-subsidies, etc., are all very suitable for the Chinese situation. For China, the key to improving electricity pricing is establishing a power trading platform that is independent from the power companies and administrative organizations (the PDRC). Furthermore, this platform can separate the power transmission enterprises from the settlement rights of all power transactions so that transmission enterprises may not be able to exert their influence on the transmission and retail pricing. On this basis, China should legislate to establish an independent regulator to manage the power pool and oversee electricity transmission, generation and retail market, disclosure of power pricing formulas, and clarify the responsibilities of various pricing agencies.

The Chinese government also should issue effective regulations through the State-owned Assets Supervision and Administration Commission to avoid transmission companies' vertical monopoly. Improving public participation in power pricing is also an essential job in China; separating the pricing power from administrative organizations helps the public build confidence in any hearing, they may start to participate and speak.

In summary, China is eager to establish a market-based pricing system for electricity as soon as possible; the experience of Alberta, one of the provinces with the complete electricity marketization in North America, is worth learning from. This paper has provided practical ideas and suggestions for the marketization of electricity pricing for the world's largest electricity supply country and help China build a reasonable power pricing system, reduce carbon emissions, and solve power shortages.

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